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THE VALUE OF OAK LEAVES FOR FORAGE.

By

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Thesis
Bachelor of Science
College of Agriculture.
J.C.R.

Berkeley, California

April 21st, 1903



THE UNIVERSITY OF CHICAGO

1964

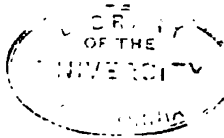
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THE VALUE OF OAK LEAVES FOR FORAGE.

During the summer and fall of 1902, while experting a forest reserve in the north Coast Ranges, the writer noticed with surprise and interest the eagerness with which leaves of certain oaks were eaten by live stock. Having this fact in mind, many observations were made in regard to the forage value of each species of oak occurring in the Coast Ranges. These observations, while confined more especially to the extent to which each species was eaten by stock, included also the range or distribution, altitude, and mode of occurrence.

Later in the year, in order to ascertain if possible whether these observations indicated fully the real value and significance of these oaks for forage, a chemical analysis was undertaken covering six species of oaks and one of poison oak. Only those species were chosen which occur on hills, ridges, and mountains where tillage is impossible; and the object kept continually in mind was the forage value of the leaves of the different species.

It is the purpose of this paper to give in full the results of both observation and analysis, and to discuss the harmony or lack of harmony between the two.

BOTANICAL SURVEY.

The Ranges covered by the investigation are those situated in

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Lake County above Clear Lake, in eastern Mendocino County above Ukiah to Humboldt County, in the western parts of Colusa and Glenn Counties, and in southwestern Tehama County. This area is typical of all the North Coast Ranges, and, in regard to oaks, may be taken also as a type of the South Coast Ranges. Thus the browsing areas of the Coast Ranges alone cover about one-third of the State. Adding to these, those areas of the lower Sierra foot-hills which are covered by many of these same species of oaks, we have, as the entire region enriched by browsing oaks, about one-half the State area.

The six species of oaks and the poison oak, (a species of Sumach), chosen from this browsing area for investigation and discussion here are all exclusively Californian and peculiar to the State with the one exception of *Quercus Garryana*, which crosses south from Oregon in the Coast Ranges.

Each of these oaks varies in range according to temperature, altitude and humidity; and the value of each species as a browser increases almost directly with the altitude, except when modified by exposure to the direct rays of the sun. Beginning on the lower hills, the six species succeed one another in nearly distinct zones or ranges, as follows:-

Blue Oak, (*Quercus douglasii*,) Scrub Oak and Curl-leaf Scrub Oak, (*Q. dumosa* and its variety, *revoluta*,) Canyon Live Oak, (*Q. wislizenii*,) Maul Oak, (*Q. chrysolepis*), Black Oak, (*Q. californica*), and White Mountain Oak, (*Q. Garryana*).



In addition to these, the poison-oak, (*Rhus diversiloba*), is found commonly everywhere, on hills, slopes, and by streams.

The following description will attempt to characterize each individual species in the above order, as regards form, mode of occurrence, range, and the forage value as indicated by the stock feeding upon it.

BLUE OAK (*Quercus douglasii*).

The Blue, or Rock, Oak, (*Quercus douglasii*), reaches, in favored localities, a height of 20 ft., but is commonly found as a small tree about 12 feet high, or as a shrub from 4-6 feet in height. It is oval or round in appearance and is covered densely with dark bluish leaves. The leaves are obovate to oblong with lobes commonly increasing in size toward the apex. In young trees and shrubs the leaves are inclined to become spinescent. The acorns, borne in shallow cups, are oval to ovate-acute and are about 1 to 1-1/8 inches long.

In altitude, this oak is limited to the low foothills and dry valleys where the soil is hard and rocky, and never ranges upward to the higher slopes and valleys. It is found most abundantly in the dry foothills of the inner Coast Ranges, but has a complete range from Mendocino County and the upper Sacramento valley through the Coast Ranges and Sierra Nevada to Tejon Pass, from whence stunted individuals extend to the margin of the Mojave Desert.



***Quercus douglasii.* (Blue or Rock Oak).**
In its natural range on Eol River, Lake County.
Bloody Rock, where the last of the
Chumish Indians perished.





HERB. UNIVERSITY OF CALIFORNIA
Q. alifanensis
 C. G. Knight, Sept. 1, 1888

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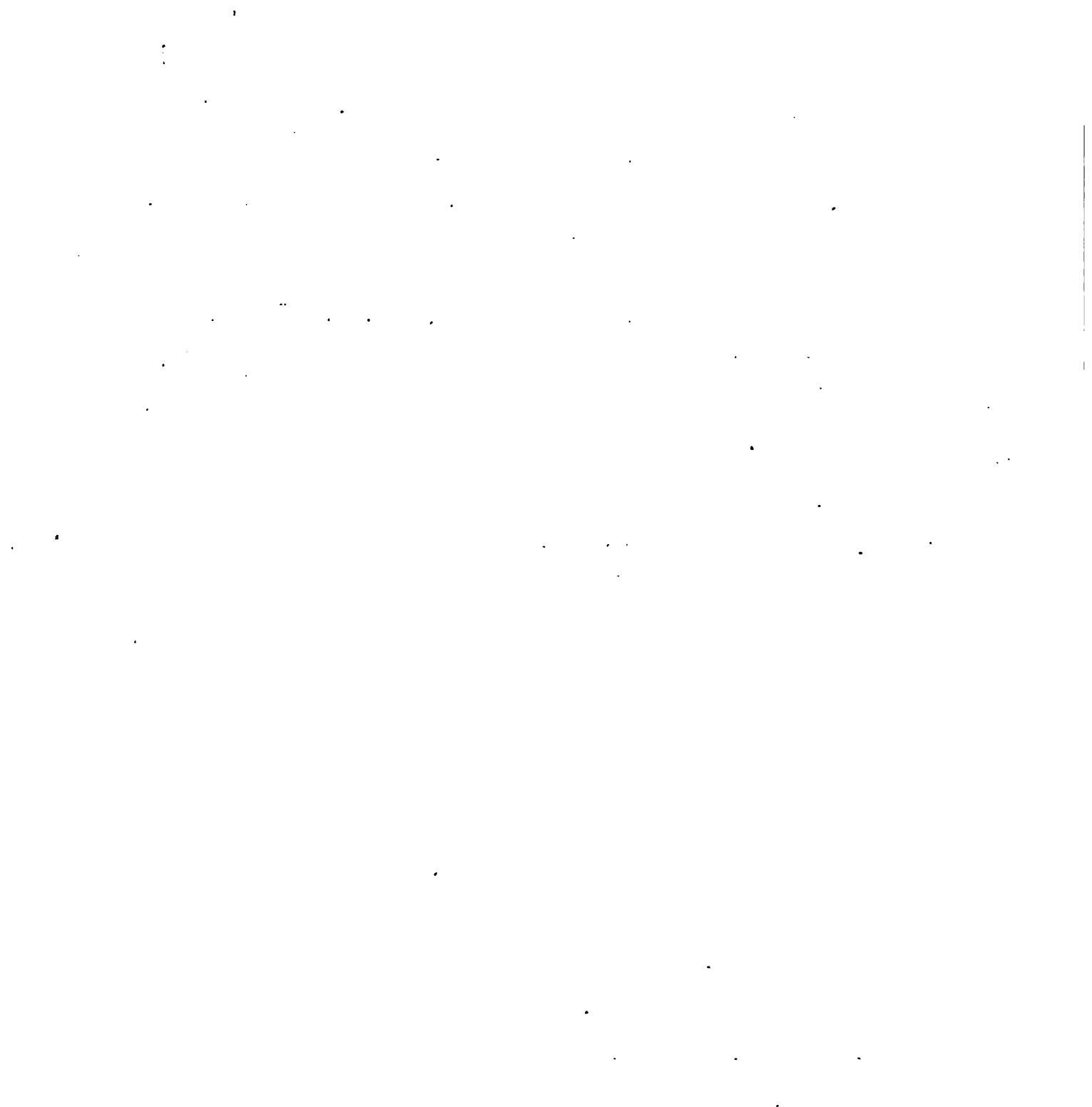
On account of the dryness of its leaf, only goats and sheep browse on the Blue Oak; but the mast, which is plentiful and quite certain, is excellent food for hogs, cattle, sheep, goats, and often for horses.

SCRUB OAK. (*Quercus dumosa*).

This oak is a round topped shrub 5 or 6 feet high, consisting of numerous closely tangled branches starting from near the ground. The twigs are usually tormentors with leaves bunched at the ends. The leaves are oblong to obovate and entire in the older trees, but are often sinuate-toothed and spinescent in young shrubs. They are pale green in color and pubescent on the ventral side. The acorns are oval and pointed, from $1/3$ to $1-1/2$ inches long, and are contained in shallow cups. The crop is light and very uncertain.

The Scrub Oak is commonly found associated with many other shrubs in the Chaparral of the mountains and upper foothill slopes in dry localities. It ranges from Mendocino County southward through the Coast Ranges to Lower California, and is also found in the foothills of the Sierra Nevada.

This shrub, on account of its low habit of growth is particularly adapted to browsing, and is one of the best for sheep and goats. Cattle, however, dislike it on account of its harsh spinescent leaves, but feed on it during the winter when snow has covered the ground, or when for any reason other food is not available.





Quercus dumosa. (Scrubb Oak).



Quercus dumosa var. *revoluta*.

(Curl-leaf Scrub Oak).



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STOCKTON, CALIFORNIA

CURL-LEAF SCRUB OAK, (*Quercus dumosa* var. *revoluta*).

(*Q. dumosa*, variety *revoluta*,) is a variety of the species with the same shape of brush and habit of growth. The leaves differ, however, in having the margins strongly revolute, thus presenting a curled appearance. The underside of the leaf is densely tomentose, and the whole leaf is thicker and rounder than that of the species. The acorns of the variety are similar in size and shape to those of the species, but are contained in even shallower cups.

This oak is seldom found south of San Francisco Bay, and reaches its greatest abundance north of Clear Lake on the dry eastern slopes of the Coast Ranges bordering on the Sacramento Valley and extending to Mt. Shasta.

The forage value of the variety is apparently the same as that of the species.

CANYON LIVE OAK, (*Quercus wislizenii*).

Canyon Live Oak, (*Quercus wislizenii*,) when found in the canyons is a tree usually 20-40 feet high, but when it passes into the chaparral, it is never higher than 8 feet. Here it is an intricately branched shrub with a round top. The bark on old trees is rough and thick, but on shrubs it is smooth. The leaves are usually oblong-lanceolate, entire, serrate or dentate, and are lustrous and dark green in color. They are about 1-1/2 inches long and 3/4 of



Quercus wislizenii. (Canon Live Oak.)

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an inch wide. The nuts ripen in the second season, and are long, sessile, slender oblong oval, set in deep scaly cups. The mast is usually scanty.

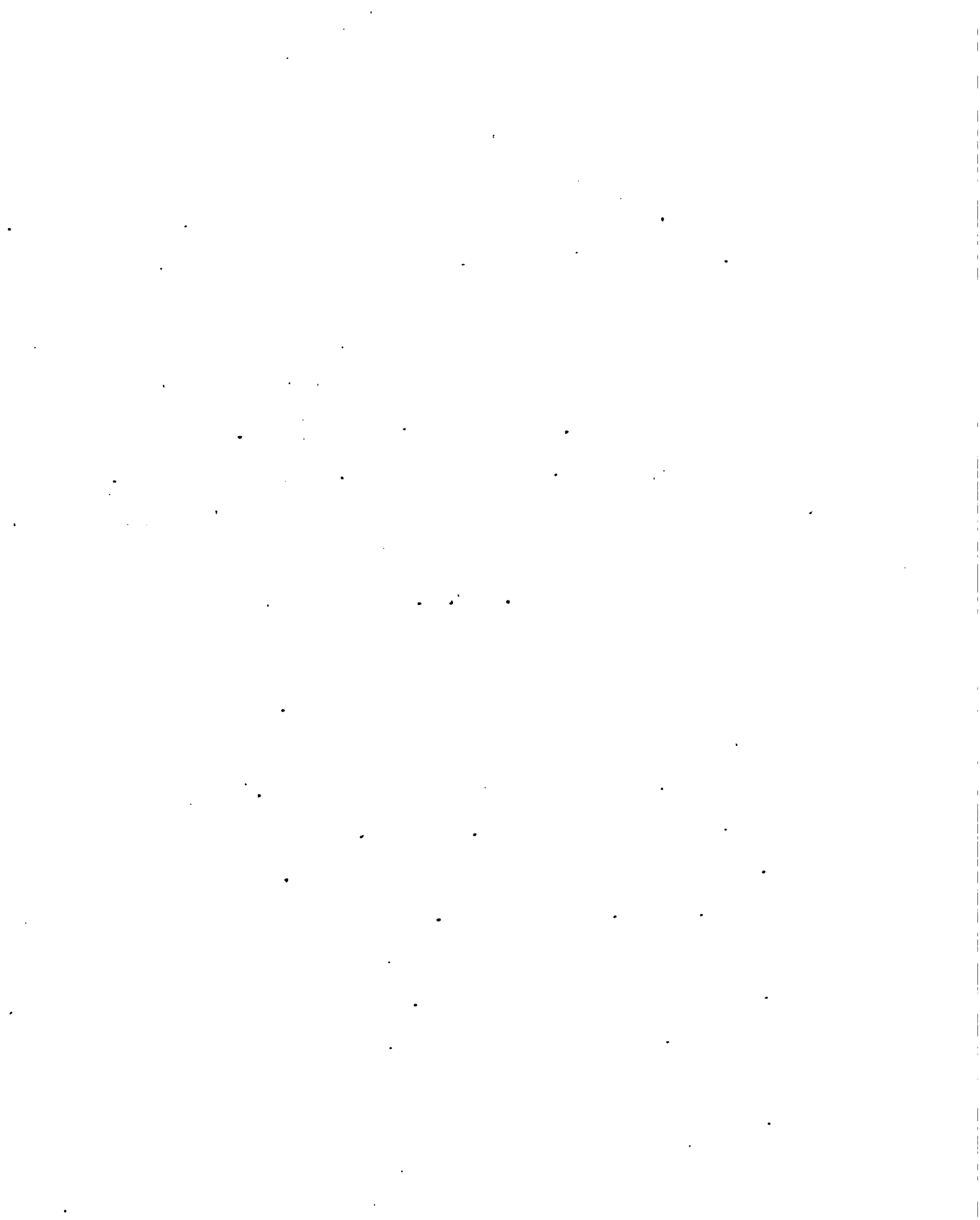
The shrub is common in the chaparral with the *Quercus dumosa* and ranges with it in altitude. It is well distributed in the Coast Ranges from Mt. Shasta to San Bernardino, usually at quite a distance from the sea. It also exists, but not commonly, from Mt. Shasta through the lower foothills of the Sierra's to Tejon pass.

The leaves of this shrub are sought in preference over those of the Scrub Oak by sheep, goats, and cattle, and it is thus often found stripped of its leaves.

MAUL OAK. (*Quercus chrysolepis*).

(*Q. chrysolepis*) when found growing on well watered and protected slopes, is a tree 40-60 feet in height, with large sweeping branches. On exposed slopes, however, and on the upper ridges and peaks, it becomes a gregarious shrub with *Q. garryana*. The leaves are oblong, acute, or cuspidate, entire on old trees but spinose-dentate on young ones and on shoots. They are pale and glaucous above, with golden tomentum below. The acorn is usually solitary, ovate or oval, 1/2 to 2 inches long, and borne in a shallow cup. The crop of mast is uncertain and is often ruined by the larvae of moths.

The range of this oak extends from Southern Oregon through





Quercus wislizenii. (Canon Live Oak.)



the Coast Ranges and Sierra Nevada and on through the San Bernardino Mountains to Lower California. It often reaches elevations of 9000 feet.

Leafl Oak is used as a "browse" by sheep and goats and sparingly by cattle.

BLACK OAK. (*Quercus californica*).

Quercus californica is a tree, 18 - 30 feet high, with several large erect branches. It is found usually near coniferous trees and apparently occupying the same belt. Young trees often occur in dense growth, and, when in this condition or when overshadowed by other trees, grows slowly, thus enabling stock to browse on them. The leaves of young trees are covered with a dense gray tomentum below, and are pubescent above. On older trees the leaves are glabrous with little tomentum. In shape, they vary from oblong to broadly ovate in outline, and each consists of about seven lobes. The nut is broadly ovate, one inch in length, and ripens in the second season. The crop is scanty and unreliable.

The range of the Black Oak extends from the Mackenzie River in Oregon through the Coast Ranges and Sierras and through the San Bernardino Mountains to Lower California. This oak often reaches elevations of 7000 - 8000 feet. It is scarce near the coast.

The flexible texture of the leaves of this oak allows it to be easily eaten by cattle and horses as well as by sheep and goats.



Quercus californica (Black Oak).



WHITE MOUNTAIN OAK, (*Quercus garryana*),

This species is divided into two sorts, differing only in range and height of individuals. The typical kind is a tree, 30-70 feet in height, with erect rigid branches. Its leaves are oblong to obovate, 4 to 6 inches long, with coarse lobes. The acorns are sessile or shortly peduncled, oval to slightly obovate, about 1-1 1/4 inches in length, contained in a shallow cup.

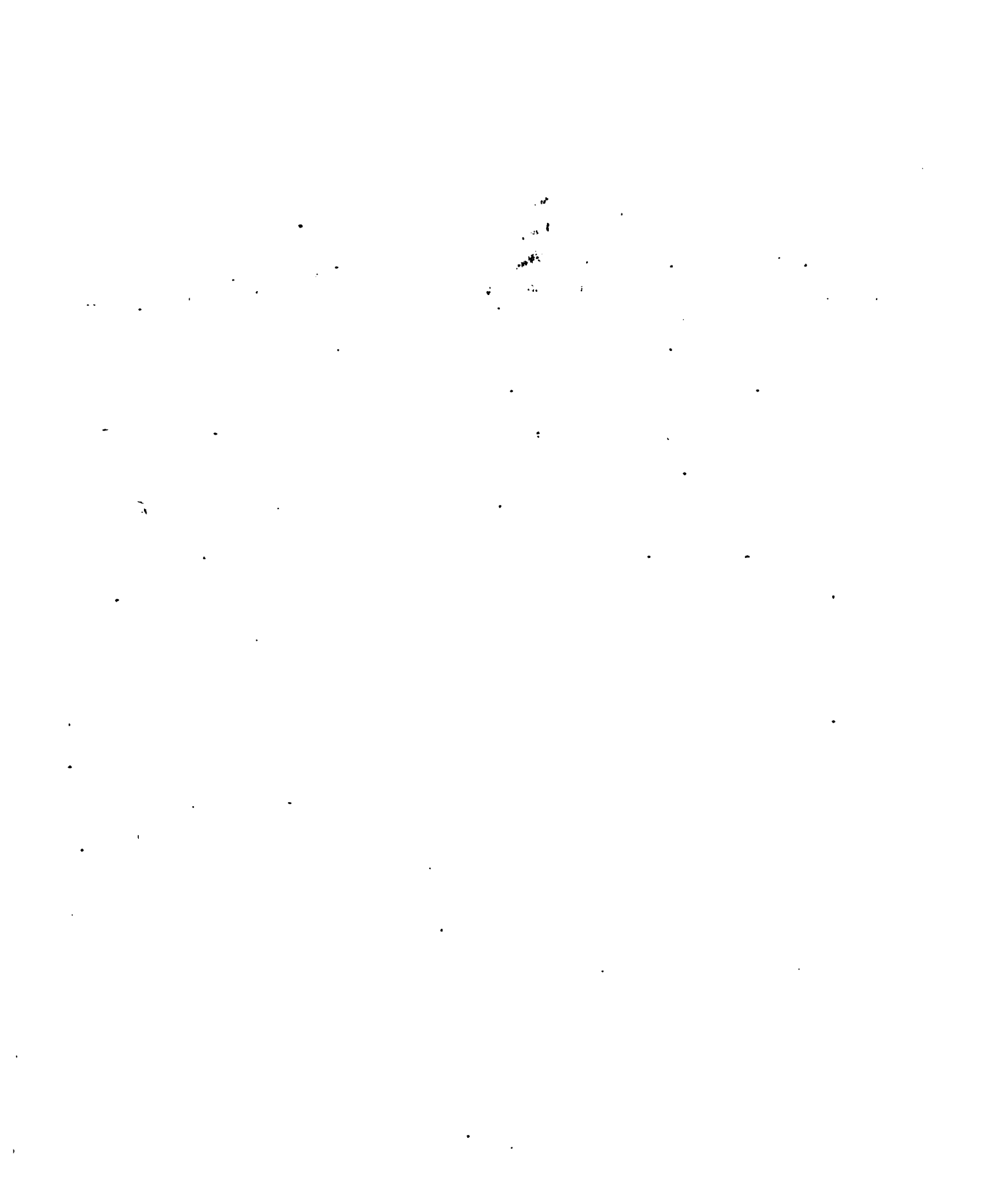
It ranges from Vancouver's Island southwestward through western Washington, Oregon, and the Coast Ranges of California to Santa Cruz. It is the only oak used for lumber on the Pacific Coast, and furnishes the oak lumber for the furniture factories of West Berkeley.

The other form of this species is a more shrub from 2-6 feet high, but identical with the larger form in every other particular.

Its range begins in an exposed portion of western Washington, where apparently it is stunted by the severe sea-breezes. Passing along the western slopes of the Cascades in Washington and Oregon, its elevation continually increases until in California it is found only on the highest ridges and peaks. Its southernmost range is Snow Mt. in Lake County.

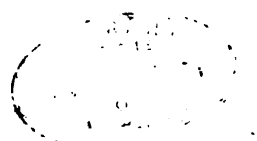
The entire range of this oak is swept by cold driving north winds which apparently serve to keep the same temperature and other conditions throughout.

It is to this form of the *Q. garryana* that stock men turn when seeking "browse" in their mountain pasture. It is gregarious





Quercus garryana. (Mountain White Oak).





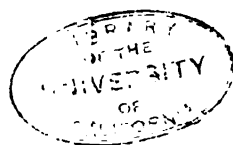
Sanhedrin Mountain in Western Mendocino County.

**Showing Quercus garryana pastures and bare places and
erosion caused by over pasturing with sheep.**



Signal Peak in eastern Mendocino County.

Slopes covered with low growing *Quercus garryana* and open places where covering has been killed by sheep. In the foreground is False Hellebore, (*Veratrum*) always an indication of spring water.



over hundreds of acres on the ridges, peaks, and higher slopes in the most exposed places of the North Coast Ranges. It forms thickest to the exclusion of everything else except *Quercus Chrysolepis*, occasionally, Wild Cherry, (*Cerasus*).

This species, almost unaided, pastures thousands of sheep and goats as well as cattle and horses, and not only keeps them up but actually fattens them. The stock keep whole ranges of it eaten down often to less than within two feet of the ground. Aside from the value of the leaves, the acorn, which is quite sweet, forms a rich diet for stock. The mast is usually sure and abundant.

POISON OAK, (*Rhus diversiloba*).

Poison Oak (*Rhus diversiloba*), is usually a small shrub from 2 to 5 feet high, but occasionally it ascends the trunks of trees as a vine to a height of 15 or 20 feet. The leaflets are orbicular to ovate, glaucous, with distinct venation. They contain an irritating and poisonous volatile oil which poisons many persons by simple contact or even by diffusion in the air. The fruit is pale, about three lines thick, and quite abundant.

Rhus diversiloba is everywhere common through the hilly portions of California.

In the ranges the leaves and berries are readily eaten by sheep, goats, and horses, but not by cattle as far as could be as-





Rhus diversiloba. (Poison Oak).

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certained by observation and numerous inquiries. Many of the bushes are stripped entirely of leaves long before they would naturally drop them.

In summing up the value of these California oaks, the common classification into "live", or evergreen, and deciduous will be made. The former class includes Scrub Oak and Curl-Leaf Scrub Oak, (*Quercus dumosa* and variety *revoluta*) Canyon Live Oak, (*Q. wislizenii*), and Maul Oak, (*Q. chrysolepis*). The deciduous oaks consist of Blue, or Rock, Oak, (*Q. douglasii*), Black Oak, (*Q. californica*), and Mountain White Oak, (*Q. garryana*). The Poison Oak, (*Rhus diversiloba*), is also deciduous.

The live oaks, as seen in the previous descriptions, occupy the brush areas on the slopes and ridges, and, except for a few isolated specimens of *Quercus chrysolepis*, never grow within the timbered, or coniferous, belt. These live oaks, therefore, occupy a continuous belt of country which is free from snow except for occasional short periods. This belt, therefore, is used as a winter range for holding over stock when feed is scarce in the valleys and the deep snows cover the mountains. Sheep and goats are kept in good condition on these live oaks, but cattle and horses do not eat them to any extent until other food cannot be obtained. Then this "browse" keeps them in feed until other is available.

The deciduous oaks, not taking into account the *Quercus doug-*

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lesli which is of little forage value, are found in the timber belt or above it. The leaves of the deciduous oaks, in contrast to the harsh spinescent ones of the live oaks, are larger, lobed and soft. This enables cattle and horses to eat them with ease, and as is also true of sheep and goats, they actually fatten on the leaves of the Black Oak and White Mountain Oak of these upper ridges and peaks.

From the observations just recorded concerning these several species of oaks, it would seem that the nutritive value increases with the altitude. To verify this, and to ascertain if possible their relative food values, a chemical analysis of each species was made.

For the purpose of this analysis the leaves were gathered during the month of September when they were fully mature. Only those which were green and vigorous were taken. These were dried in a room of ordinary temperature, and were then ground to a fine powder.

In gathering the Poison Oak, (*Rhus diversiloba*), the writer was badly poisoned even though gloves were worn. After drying at ordinary room temperature, the leaves were pressed into the mill with bare hands and no poisonous effects followed. Thus it would seem that the irritating and poisonous oil of this plant is volatile at a comparatively low temperature.

In the analysis of these oak leaves, the analysis of foods





as set forth in Bulletin 46, Bureau of Chemistry, U.S.D.A., was followed. In this analysis, however, certain errors appeared in the ether extract and in the nitrogen free extract. These errors were due to certain peculiarities of composition of the oaks.

In the determination of fat, or ether extract, quantities of chlorophyll, the green coloring matter in the leaves, remained in the extract. No quantitative method being known for the extraction of chlorophyll, this, together with the gums and resins which are contained within the leaves or on the tomentum and pubescence of the outside, increased the ether extract beyond its true percentage.

After determining the nitrogen-free extract, which consists of sugar, starch, pentosans, etc., the percentage appeared inexplicably high. The only possible explanation seemed to be that the tannin content, which, by the method of difference, falls in this group, had not been accounted for. It was necessary, then, to make an analysis for tannin.

In determining the tannin, the method of Günther was followed; that is, two grams of the substance to be analysed was taken and the tannin extracted with hot water, in which it is easily soluble, until a dilution of 1 to 400 parts was obtained. This dilution is necessary in order that potassium permanganate may completely oxidize tannin in the presence of indigo-carmino. The oxidizing power of the indigo-carmino was determined by extracting



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1. The first of the two main parts of the book is devoted to the study of the history of the English language. It begins with a chapter on the prehistoric period, which deals with the languages spoken in Britain before the arrival of the Romans. This is followed by a chapter on Old English, which covers the period from the fifth to the eleventh centuries. The third chapter is on Middle English, which spans the years from the twelfth to the fifteenth centuries. The final chapter in this section is on Modern English, which begins in the sixteenth century and continues to the present day.



Signal Peak in eastern Mendocino County.

Slopes covered with low growing *Quercus garryana* and open places where covering has been killed by sheep. In the foreground is False Hellebore, (*Veratrum*) always an indication of spring water.



over hundreds of acres on the ridges, peaks, and higher slopes in the most exposed places of the North Coast Ranges. It forms thickest to the exclusion of everything else except *Quercus chrysolepis*, occasionally, Wild Cherry, (*Cerasus*).

This species, almost unaided, pastures thousands of sheep and goats as well as cattle and horses, and not only keeps them up but actually fattens them. The stock keep whole ranges of it eaten down often to less than within two feet of the ground. Aside from the value of the leaves, the acorn, which is quite sweet, forms a rich diet for stock. The mast is usually sure and abundant.

POISON OAK, (*Rhus diversiloba*).

Poison Oak (*Rhus diversiloba*), is usually a small shrub from 2 to 5 feet high, but occasionally it ascends the trunks of trees as a vine to a height of 15 or 20 feet. The leaflets are orbicular to ovate, glaucous, with distinct venation. They contain an irritating and poisonous volatile oil which poisons many persons by simple contact or even by diffusion in the air. The fruit is pale, about three lines thick, and quite abundant.

Rhus diversiloba is everywhere common through the hilly portions of California.

In the ranges the leaves and berries are readily eaten by sheep, goats, and horses, but not by cattle as far as could be as-



Rhus diversiloba. (Poison Oak).

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1. *Chlorophyll a* and *Chlorophyll b* were determined by the method of Arar and Collins (1971) using a Shimadzu 1601 UV-Visible Spectrophotometer.

lasii which is of little forage value, are found in the timber belt or above it. The leaves of the deciduous oaks, in contrast to the harsh spinescent ones of the live oaks, are larger, lobed and soft. This enables cattle and horses to eat them with ease, and as is also true of sheep and goats, they actually fatten on the leaves of the Black Oak and White Mountain Oak of these upper ridges and peaks.

From the observations just recorded concerning these several species of oaks, it would seem that the nutritive value increases with the altitude. To verify this, and to ascertain if possible their relative food values, a chemical analysis of each species was made.

For the purpose of this analysis the leaves were gathered during the month of September when they were fully mature. Only those which were green and vigorous were taken. These were dried in a room of ordinary temperature, and were then ground to a fine powder.

In gathering the Poison Oak, (*Rhus diversiloba*), the writer was badly poisoned even though gloves were worn. After drying at ordinary room temperature, the leaves were pressed into the mill with bare hands and no poisonous effects followed. Thus it would seem that the irritating and poisonous oil of this plant is volatile at a comparatively low temperature.

In the analysis of these oak leaves, the analysis of foods

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48	49	50	51	52	53	54	55	56	57	58	59	60	61	62	63	64	65	66	67	68	69	70	71	72	73	74	75	76	77	78	79	80	81	82	83	84	85	86	87	88	89	90	91	92	93	94	95	96	97	98	99	100	101	102	103	104	105	106	107	108	109	110	111	112	113	114	115	116	117	118	119	120	121	122	123	124	125	126	127	128	129	130	131	132	133	134	135	136	137	138	139	140	141	142	143	144	145	146	147	148	149	150	151	152	153	154	155	156	157	158	159	160	161	162	163	164	165	166	167	168	169	170	171	172	173	174	175	176	177	178	179	180	181	182	183	184	185	186	187	188	189	190	191	192	193	194	195	196	197	198	199	200	201	202	203	204	205	206	207	208	209	210	211	212	213	214	215	216	217	218	219	220	221	222	223	224	225	226	227	228	229	230	231	232	233	234	235	236	237	238	239	240	241	242	243	244	245	246	247	248	249	250	251	252	253	254	255	256	257	258	259	260	261	262	263	264	265	266	267	268	269	270	271	272	273	274	275	276	277	278	279	280	281	282	283	284	285	286	287	288	289	290	291	292	293	294	295	296	297	298	299	300	301	302	303	304	305	306	307	308	309	310	311	312	313	314	315	316	317	318	319	320	321	322	323	324	325	326	327	328	329	330	331	332	333	334	335	336	337	338	339	340	341	342	343	344	345	346	347	348	349	350	351	352	353	354	355	356	357	358	359	360	361	362	363	364	365	366	367	368	369	370	371	372	373	374	375	376	377	378	379	380	381	382	383	384	385	386	387	388	389	390	391	392	393	394	395	396	397	398	399	400	401	402	403	404	405	406	407	408	409	410	411	412	413	414	415	416	417	418	419	420	421	422	423	424	425	426	427	428	429	430	431	432	433	434	435	436	437	438	439	440	441	442	443	444	445	446	447	448	449	450	451	452	453	454	455	456	457	458	459	460	461	462	463	464	465	466	467	468	469	470	471	472	473	474	475	476	477	478	479	480	481	482	483	484	485	486	487	488	489	490	491	492	493	494	495	496	497	498	499	500	501	502	503	504	505	506	507	508	509	510	511	512	513	514	515	516	517	518	519	520	521	522	523	524	525	526	527	528	529	530	531	532	533	534	535	536	537	538	539	540	541	542	543	544	545	546	547	548	549	550	551	552	553	554	555	556	557	558	559	560	561	562	563	564	565	566	567	568	569	570	571	572	573	574	575	576	577	578	579	580	581	582	583	584	585	586	587	588	589	590	591	592	593	594	595	596	597	598	599	600	601	602	603	604	605	606	607	608	609	610	611	612	613	614	615	616	617	618	619	620	621	622	623	624	625	626	627	628	629	630	631	632	633	634	635	636	637	638	639	640	641	642	643	644	645	646	647	648	649	650	651	652	653	654	655	656	657	658	659	660	661	662	663	664	665	666	667	668	669	670	671	672	673	674	675	676	677	678	679	680	681	682	683	684	685	686	687	688	689	690	691	692	693	694	695	696	697	698	699	700	701	702	703	704	705	706	707	708	709	710	711	712	713	714	715	716	717	718	719	720	721	722	723	724	725	726	727	728	729	730	731	732	733	734	735	736	737	738	739	740	741	742	743	744	745	746	747	748	749	750	751	752	753	754	755	756	757	758	759	760	761	762	763	764	765	766	767	768	769	770	771	772	773	774	775	776	777	778	779	780	781	782	783	784	785	786	787	788	789	790	791	792	793	794	795	796	797	798	799	800	801	802	803	804	805	806	807	808	809	810	811	812	813	814	815	816	817	818	819	820	821	822	823	824	825	826	827	828	829	830	831	832	833	834	835	836	837	838	839	840	841	842	843	844	845	846	847	848	849	850	851	852	853	854	855	856	857	858	859	860	861	862	863	864	865	866	867	868	869	870	871	872	873	874	875	876	877	878	879	880	881	882	883	884	885	886	887	888	889	890	891	892	893	894	895	896	897	898	899	900	901	902	903	904	905	906	907	908	909	910	911	912	913	914	915	916	917	918	919	920	921	922	923	924	925	926	927	928	929	930	931	932	933	934	935	936	937	938	939	940	941	942	943	944	945	946	947	948	949	950	951	952	953	954	955	956	957	958	959	960	961	962	963	964	965	966	967	968	969	970	971	972	973	974	975	976	977	978	979	980	981	982	983	984	985	986	987	988	989	990	991	992	993	994	995	996	997	998	999	1000	1001	1002	1003	1004	1005	1006	1007	1008	1009	1010	1011	1012	1013	1014	1015	1016	1017	1018	1019	1020	1021	1022	1023	1024	1025	1026	1027	1028	1029	1030	1031	1032	1033	1034	1035	1036	1037	1038	1039	1040	1041	1042	1043	1044	1045	1046	1047	1048	1049	1050	1051	1052	1053	1054	1055	1056	1057	1058	1059	1060	1061	1062	1063	1064	1065	1066	1067	1068	1069	1070	1071	1072	1073	1074	1075	1076	1077	1078	1079	1080	1081	1082	1083	1084	1085	1086	1087	1088	1089	1090	1091	1092	1093	1094	1095	1096	1097	1098	1099	1100	1101	1102	1103	1104	1105	1106	1107	1108	1109	1110	1111	1112	1113	1114	1115	1116	1117	1118	1119	1120	1121	1122	1123	1124	1125	1126	1127	1128	1129	1130	1131	1132	1133	1134	1135	1136	1137	1138	1139	1140	1141	1142	1143	1144	1145	1146	1147	1148	1149	1150	1151	1152	1153	1154	1155	1156	1157	1158	1159	1160	1161	1162	1163	1164	1165	1166	1167	1168	1169	1170	1171	1172	1173	1174	1175	1176	1177	1178	1179	1180	1181	1182	1183	1184	1185	1186	1187	1188	1189	1190	1191	1192	1193	1194	1195	1196	1197	1198	1199	1200	1201	1202	1203	1204	1205	1206	1207	1208	1209	1210	1211	1212	1213	1214	1215	1216	1217	1218	1219	1220	1221	12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From the observations just recorded concerning these several species of oaks, it would seem that the nutritive value increases with the altitude. To verify this, and to ascertain if possible their relative food values, a chemical analysis of each species was made.

For the purpose of this analysis the leaves were gathered during the month of September when they were fully mature. Only those which were green and vigorous were taken. These were dried in a room of ordinary temperature, and were then ground to a fine powder.

In gathering the Poison Oak, (*Rhus diversiloba*), the writer was badly poisoned even though gloves were worn. After drying at ordinary room temperature, the leaves were pressed into the mill with bare hands and no poisonous effects followed. Thus it would seem that the irritating and poisonous oil of this plant is volatile at a comparatively low temperature.

In the analysis of these oak leaves, the analysis of foods

all the tannin by means of animal charcoal and titrating with potassium permanganate. The difference between the two titrations was the tannin oxidized by the potassium permanganate.

With these exceptions in the ether extract and the nitrogen-free extract, the regular official method was followed; and the succeeding table gives the results of the analysis of the different species of oak in an air-dry condition. As a means of exact comparison, these results were calculated first to a water-free basis, and finally, to an alfalfa hay basis. The analyses were all carried out in duplicate and the averages taken as follows:

ANALYSES OF OAK LEAVES.

Samples Air Dry.

Species	H ₂ O %	Ash %	Protein %	Fibre %	Tannin %	N-Free Extract %	Ether Extract %
<i>Quercus douglasii</i>	6.21	9.32	8.32	35.35	5.00	34.55	4.25
" <i>dumosa</i> & variety	3.90	9.42	9.16	26.79	14.06	31.41	5.26
" <i>wislizenii</i>	3.54	9.66	10.95	29.48	9.62	30.89	5.88
" <i>chrysolepis</i>	6.53	9.62	8.32	30.35	10.16	31.52	3.50
" <i>californica</i>	6.10	9.35	8.15	19.23	10.62	40.50	7.06
" <i>garryana</i>	4.59	9.44	15.05	16.26	9.01	40.18	5.47
<i>Rhus diversiloba</i>	5.39	8.66	6.85	25.13	6.42	41.05	6.50

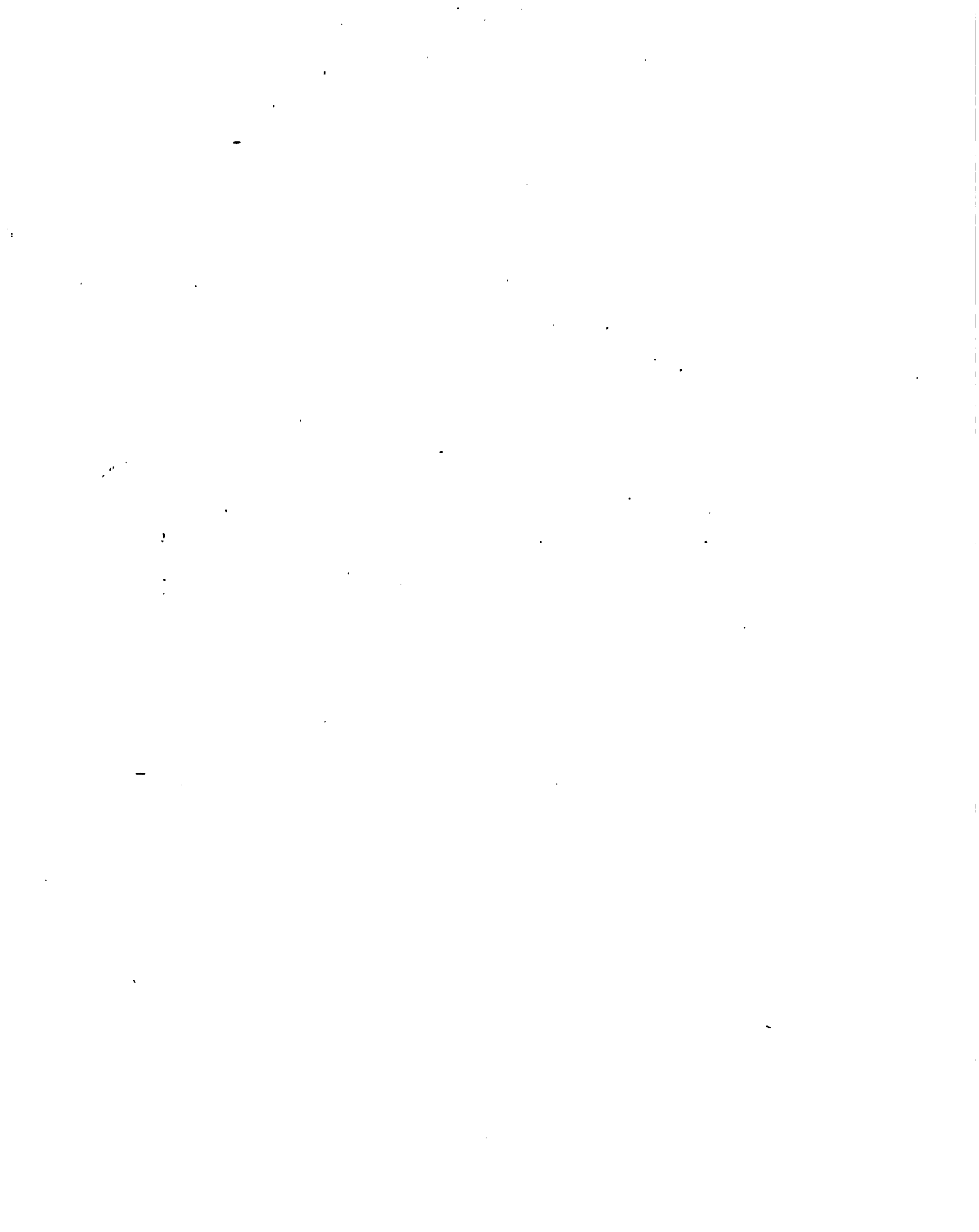
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" <i>chrysolepis</i>	6.53	9.62	8.32	30.35	10.16	31.52	5.50
" <i>californica</i>	5.10	9.35	8.15	19.23	10.62	40.50	7.06
" <i>garryana</i>	4.59	9.44	15.05	16.26	9.01	40.18	5.47
<i>Rhus diversiloba</i>	5.39	8.66	6.85	25.13	6.42	41.05	6.50



Water-free.

Species	H ₂ O	Ash	Protein	Fibre	Tannin	N-Free Extract	Ether Extract
	%	%	%	%	%	%	%
<i>Quercus douglasii</i>		9.83	8.78	35.18	5.28	36.45	4.48
" <i>dumosa</i> and variety		9.80	9.53	27.88	14.63	32.69	5.47
" <i>wializenii</i>		10.02	11.85	30.56	9.97	32.02	6.07
" <i>chrysolepis</i>		10.29	8.90	32.47	10.89	33.73	5.74
" <i>californica</i>		9.85	8.59	20.25	11.19	42.68	7.44
" <i>garryana</i>		9.90	15.77	17.04	9.44	42.11	5.73
<i>Rhus diversiloba</i>		9.15	7.24	26.56	6.79	43.39	6.87

Water on Alfalfa Basis.

<i>Quercus douglasii</i>	10.95	8.75	7.83	31.32	4.70	32.46	3.90
" <i>dumosa</i> and variety	10.95	8.72	8.48	24.83	13.03	29.11	4.87
" <i>wializenii</i>	10.95	8.92	10.11	27.21	8.88	28.52	5.41
" <i>chrysolepis</i>	10.95	9.18	7.92	28.91	9.70	30.02	3.33
" <i>californica</i>	10.95	8.77	7.65	18.03	9.96	38.01	6.63
" <i>garryana</i>	10.95	8.82	14.04	15.18	8.41	37.50	5.10
<i>Rhus diversiloba</i>	10.95	8.15	6.44	23.65	6.04	38.84	6.13
<i>Medicago sativa</i>	10.95	6.43	17.60	22.63	—	39.31	3.08

In the discussion of the chemical analysis of these species, alfalfa hay is selected for comparison because alfalfa seems to be the best and commonest forage plant in California. A comparison with this plant then naturally sets forth the value of oak leaves

for forage to better advantage than a comparison with any other stock feed.

ASH CONTENT.

In comparing the ash content of oak leaves and alfalfa, it is noted that the ash of oaks varies but little in various species. This variation is not more than four-tenths of one percent, while the average ash for all the species is somewhat greater than 8.75 percent. This percentage is 2-1/4 percent greater than in alfalfa hay.

As all the mineral, and hence the bone forming, materials of the plant are in the ash, oak leaves have thus a greater value for growing stock than has alfalfa.

PROTEIN CONTENT.

Proceeding to the protein, or muscle forming, content, greater variations are encountered. The comparison shows alfalfa to contain more than twice as much protein as any of the oaks with the exception of two species, *Quercus wislizenii* and *Quercus garryana*. The former averages 10.11 and the latter 14.04 percent. *Quercus garryana*, therefore, approaches alfalfa closely. The other species, though falling far below alfalfa are not poor in protein. The average is nearly eight percent, which is one-half of one percent higher than oat hay - the best of cereal hays.

These analyses indicate that oak leaves are superior in

muscle forming ingredients to non-leguminous hay; that one species, (*Quercus wislizenii*), is equal to bur clover hay; and the best species, (*Quercus garryana*), almost equal to alfalfa hay.

CRUDE FIBRE.

In oak leaves the crude fibre is as variable as the protein, ranging from over 30 percent in *Quercus douglasii* to 15 percent in *Quercus garryana*. With the exception of two of the deciduous oaks, *Quercus californica* and *Quercus garryana*, the oak leaves are considerably higher in crude fibre than alfalfa. This crude fibre, or roughage, in oaks tends to produce a wide nutritive ration.

ETHER EXTRACT.

The fat, or more correctly speaking, the ether extract, is considerably higher than in alfalfa in all the species, and increases to twice as much in *Quercus wislizenii* and *Quercus californica*. This ether extract does not represent pure fat but includes the chlorophyll, waxes, and resins, which cannot be separated from the true fat.

These waxes and resins serve to protect the leaves from drying winds and inclement weather, and usually occur in the tomentum or pubescence which cover some leaves. In some cases, as in *Quercus californica*, the waxes and resins are distasteful to stock, thus decreasing their forage value.

NITROGEN-FREE EXTRACT.

In oaks the nitrogen-free extract, consisting of starch, sugars, pentosans, etc., does not equal alfalfa in any species; and, in Scrub Oak, falls as far below as 10 percent. This fact indicates a lower fattening and heat producing power than in alfalfa.

TANNIN.

Tannin is an astringent principle found in many plants. Aside from its astringent properties, it is acrid, and therefore offensive to the palates of animals. In the stomach, it precipitates the pepsin and peptones, thus preventing the formation of dextrose and hindering digestion. Great thirst and constriction in the digestive tract usually follows an overdose of it. These effects are not so marked in some tannins as in others for some do not have so great a precipitating power as do others.

In determining the tannins in the oaks, it was found to vary greatly in the different species but did not serve as an infallible indication of the value of the leaves for forage. For example, *Quercus douglasii*, which is the poorest forage oak analyzed, is lowest in tannin, while *Quercus dumosa*, a species preferred by sheep and goats contains 13 percent, the largest amount of tannin determined in any one species.

The average of tannin for all the oaks is a little over 10

percent. By tasting the powdered specimens of the various species, the intensity of acidity coincides with the tannin percents. In comparison with oak leaves, alfalfa contains an inappreciable amount of tannin.

WATER.

Although the water content of the oak leaves was placed on an alfalfa hay basis, this does not indicate their true comparison when both are green. Green alfalfa contains eighty percent of water which is from 10 to 20 percent higher than that in the various species of oaks. This shows the oak leaves to be a somewhat more concentrated feed in regard to protein, ash, and nitrogen-free extract, than appears in the comparison on an alfalfa hay basis.

INJURIOUS CONSTITUENTS.

Judging from the results of the chemical analyses of these oak leaves, they would seem to occupy a high place among forage plants. This would be the case were it not for excessive amount of three of the chemical constituents; namely, crude fibre, resins and waxes, and tannin.

The high percent of crude fibre taken together with the low percent of nitrogen-free extract produces a coarser and less nutrititious feed than leguminous crops.

The resins have pungent and disagreeable flavors which render

them distasteful to stock. A good example of this is seen in the *Quercus californica* before cited. The leaves of the young trees and shrubs of this species contain no more tannin than those of most of the other species, are only 1-1/3 percent below alfalfa in nitrogen-free extract, have a fair amount of protein, are low in crude fibre, and are large and soft. These qualities should produce a feed superior to oat hay. This is not the case, however, for stock avoid it to a great extent on account of the resins and waxes in the dense tomentum covering the leaves. These waxes and resins serve as a protection against drying winds and severe weather, and all the oaks have more or less of them.

As compared with the crude fibre and resins, tannin of oak leaves, as before stated, is not only bitter and astringent but greatly interferes with digestion.

CONCLUSION.

In summing up the value of the forage oaks, from chemical analysis and observations in the field, the conclusion is reached that the facts observed coincide in most cases with the facts determined by analysis. For instance, the deciduous oaks possess a higher nutritive value than the live oaks and are, as would be expected, more readily eaten by horses, cattle, sheep, and goats. In some cases, however, certain physical conditions modify these relations. This is true in the case of the live oaks. These con-

tain a sufficiently high proportion of nutrients and yet only sheep and goats thrive upon them. This is due to the thick harsh leaves with their spinescent teeth which prevent horses and cattle from successfully eating them.

PASTURING OAKS.

Although all stock prefer the deciduous oaks of the higher altitudes, yet indiscriminate pasturing causes much damage to the forests and ground-cover. When sheep and goats are allowed to browse on the deciduous oaks of the timbered area, they kill by nibbling and trampling, the seedling conifers, kill shrubs by over browsing, and cut up the slopes in trails which become deep gullies during the rainy season. This could be avoided by pasturing the sheep and goats on the "live oaks" of the lower chaparral or brush areas, the only necessary precaution being to prevent too many congregating in one place, thus avoiding too much trampling and gulleying.

Since cattle and horses are unable to thrive on the live oaks, and since they do not browse close enough to kill shrubs, never browse on young conifers, nor cut up slopes by trails, they may profitably be pastured on the timbered areas and on the higher altitudes.

Thus, this oak area, comprising half the whole state, can, by a conservative and well-regulated system of browsing, be made to

- pasture sheep and goats throughout the year, and all stock during the summer months and also during seasons of drought or when winter conditions make other feed inaccessible.



B I B L I O G R A P H Y .

- 1. - Flora of Western Middle California - Jepson.**
- 2. - Silva of North America - Sargent.**
- 3. - Check List of the Forest Trees of the United States, Their Names and Ranges. - Bulletin No. 17, Bureau of Forestry - Sudworth.**
- 4. - Stock Ranges of Northwestern California - Bulletin No. 12, Bureau of Plant Industry. - Davy.**
- 5. - Feeding of Farm Animals - University of California, College of Agriculture - Bulletin 132 - Jaffa and Anderson.**
- 6. - Feeds and Feeding - Henry.**
- 7. - Official Methods of Analysis Adopted by the United States Association of Chemistry - Bulletin 46, Bureau of Chemistry, U. S. Department of Agriculture.**
- 8. - Plant Analysis - Dragendorff.**
- 9. - Chemie der Nahrungs- und Genussmittel - König.**

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